

MCSD Water Model Technical Report

To: Norman Shopay-General Manager, Greg Orsini-Operations Director
Date: July 9, 2012
From: Brian Anspach, North Coast Mapping Solutions
Subject: **Technical Report Detailing Water Model Results for the
McKinleyville Water Distribution System.**

Executive Summary

This report provides a summary of the water model analysis conducted for the McKinleyville Community Services District (MCSD) water distribution system. The system was analyzed using WaterCADv8i (Select3) water modeling software and was evaluated for pressure, flow, fire flow availability, storage, pump efficiency, and overall system reliability for both current and future demands.

The report includes four analyses and result sets: the current state; addition of 4.5 MG of storage at the Cochran tank site; the addition of 2.5 MG of storage at the end of Mather Road; and 20 year growth projections. Each analysis is based on discussions with District staff, MCSD criteria, and California Department of Public Health (CDPH) requirements.

The current state scenario evaluates the distribution system under existing conditions and proved to have issues in regards to fire flow and minimum storage requirements. Under average daily demand (ADD) 6 hydrants in the high elevation Dows Prairie and three hydrants in the McCluski Hill service areas failed to deliver the required 1000 gpm fire flow. Based on preliminary findings the current system cannot satisfy the five days of average ADD required by MCSD. From storage only, where pumps are off and no water is supplied from Humboldt Bay Municipal Water District (HBMWD), there is approximately 2 days of water. The current system cannot satisfy the high-density build out proposed by the Humboldt County General Plan update in regards to minimum storage, there would be less than two days water available from storage only.

The addition of 4.5 MG of storage increases storage for demand and improves fire flow availability, but cannot provide 1000 gpm to four hydrants in the high elevation Dow's Prairie area; and, three hydrants in the McCluski Hill service areas. With the addition of 4.5 MG, the system still cannot satisfy the five days of storage criterion under average daily demand, there is approximately 4 days of water available from storage only. The addition of 4.5MG of storage cannot handle the Humboldt County proposed high-density

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build-out in regards to minimum storage requirements there would only be 2.5 days of water available from storage only.

The model was also analyzed with 2.5 MG of additional storage (including the 4.5 MG at the Cochran tank site) located at the end of Mather Road in the Dow's Prairie area. The addition of 2.5 MG in the Dows Prairie area provides the required 1000 gpm fire flow to all hydrants and satisfies the minimum storage requirement of five days average daily demand (from storage only). The addition of 2.5 MG still does not handle the Humboldt County Proposed high-density build out in regards to minimum storage (3.5 days of water available).

By the year 2020 the average daily demand is expected to be 1.78 MG per day and 2.04 MG per day by 2030. In order to satisfy the MCSD minimum storage requirement by the year 2020, from the current state, 10.5 MG of additional storage will be required. For the year 2030 12 MG of additional storage will be required to satisfy the MCSD minimum storage requirement of five days average daily demand from storage only.



Reference: 011034.100

July 13, 2012

Norman Shopay
McKinleyville Community Services District
1656 Sutter Road
McKinleyville, CA 95519

Subject: MCSD Water Model Report Letter of Concurrence

Dear Norman Shopay:

The McKinleyville Community Services District (MCSD) has developed a water model with oversight and assistance from SHN Consulting Engineers & Geologists, Inc. (SHN). Initial services performed by SHN included but were not limited to the following:

- Data collection and review
- Data refinement and model preparation
- Preliminary model development
- Assisting in model calibration/validation
- Developing system demands and appropriate demand allocation
- Providing technical documentation of services provided ("Technical Memorandum: MCSD Water Distribution System-Preliminary Assessment, Revision 3," August 2011)

After initial development of the water model, MCSD incorporated information from SHN and MCSD to create a model representing the water distribution system of McKinleyville and run steady state simulations, extended period simulations, and fire flow simulations.

The objective of this letter of concurrence is to review and confirm that SHN agrees with the following:

- Water model calibration and validation
- Accuracy of the water model
- Accuracy of the items presented in the water model report from MCSD (*Technical Report of Water Distribution System Water Model for MCSD, June 2012*)

SHN has reviewed and approves of the methodologies employed to develop the MCSD water distribution system model. The water model, as it stands to date, accurately represents the MCSD's existing systems and proposed conditions as outlined in attached *Technical Report of Water Distribution System Water Model for MCSD* as prepared by North Coast Mapping Solutions & McKinleyville Community Services District (June 2012).


Norman Shopay
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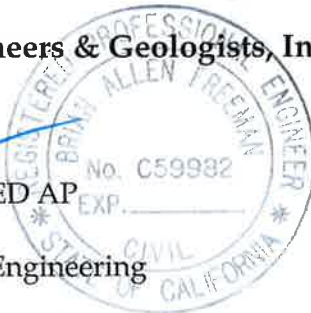
Therefore, this letter of concurrence, set forth by Brian A. Freeman, PE of SHN Consulting Engineers & Geologists, Inc. approves methods and practices used to create the MCSD water distribution model and the attached report.

SHN is not responsible for any tasks performed beyond what is stated in the initial *Technical Report of Water Distribution System Water Model for MCSD*, any future changes to the water model, and/or any future technical recommendations created from the water model. This letter of concurrence is for the sole purpose of validating the current state of the MCSD water model is capable of providing accurate results, dependent upon proper use of the model.

Sincerely,

SHN Consulting Engineers & Geologists, Inc.


Brian A. Freeman, PE LEED AP
Senior Civil Engineer
Department Head, Civil Engineering



Daniel S. Love
Staff Engineer

BAF: DSL:lms

Enclosures: Technical Report of Water Distribution System Water Model, June 2012
August 2011, "Technical Memorandum: MCSD Water Distribution System–
Preliminary Assessment, Revision 3"



Technical Memorandum

Reference: 011034.050
Date: August 18, 2011
To: Norman Shopay, MCSD
Copy to: Greg Orsini, MCSD; Sharon Denison, MCSD
From: Dan Love – SHN Assistant Project Engineer
Subject: MCSD Water Distribution System–Preliminary Assessment–Revision 3

MCSD Existing System Conditions

Base Demand Development (Preliminary)

The McKinleyville Community Services District (MCSD) supplies water to single-family residential, multi-family residential, and commercial services. These services provided approximately 552.8 million gallons (MG) of water for an equivalent population of approximately 15,400 people for the entire year 2010. This is approximately 98.3 gallons per day per capita (gpcd), with an average daily demand of 1.51 million gallons a day (MGD).

The typical household, or single family residence, in Humboldt County is comprised of approximately 2.58 persons per household; thus creating a demand of 254 gallons per day per household, or Equivalent Residential Unit (ERU). ERUs represent the water consumption for a typical single family residential service. Total ERUs for MCSD are calculated by dividing the average daily demand (1.51 MGD) by the typical single family residential water use (254 gpd). The total ERUs served by MCSD are approximately 5,940. This total represents the average daily use for the entire district and is broken up into three types of service connections: Single Family, Multi-Family, and Commercial (Table 1).

NOTE: *In the interest of time, the preliminary base demand allocation was performed to approximate usage per zoned parcel at this point in the development of the water distribution study. As the project proceeds, MCSD Operations and SHN will create a more accurate representation of water service usage per service (that is, single family, multi-family, or commercial).*

Table 1 provides preliminary data for existing system service connections from 2010 data provided by MCSD (MCSD, 2011).

Civil | Environmental | Geotechnical | Surveying
Construction Monitoring | Materials Testing
Economic Development | Planning & Permitting

Table 1 Base Demand Comparison McKinleyville, California			
Service Type	Existing System Services Connections¹	Equivalent Residential Units²	Total Demand³ (MGD)⁴
Single Family Residential	4,680	4,680	1.19
Multi-Family Residential	401	945	0.24
Commercial	234	315	0.08
Total	5,315	5,940	1.51
1. According to an email from Greg Orsini, June 13, 2011. 2. Equivalent Residential Units (ERUs) are based on average daily water use per typical household. 3. Total demand will be delineated between Single Family Residential, Multi-Family Residential, and Commercial users. Total Demand equals ERUs multiplied by Average Daily Demand per ERU, in gallons per day. 4. MGD: million gallons per day			

A water distribution model is currently being developed that will run scenarios using Average Daily Demands (ADD), Maximum Daily Demands (MDD), and Peak Hourly Demand (PHD). The ADD, MDD, and PHD values are calculated according to Title 22 California Code of Regulations (CCR) Section 64554.(b)(3)(A-D) for annual water usage data, and are shown in Table 2. As delineated in the section, the MDD is 2.25 times the ADD, and the PHD is 1.5 times the average hourly MDD. Also, according to Title 22 CCR section 64554.(a)(2), “For systems with 1,000 or more service connections, the system shall have storage capacity to meet four hours of peak hourly demand (PHD) with source capacity, storage capacity, and/or emergency source connections.” (CDPH, 2009).

Table 2 summarizes McKinleyville’s system demands as a whole.

Table 2 Storage Capacity Design Demands¹ McKinleyville, California (in MGD)²			
Service Area	Average Daily Demand (ADD)³	Max Daily Demand (MDD)	Peak Hour Demand (PHD)⁴
MCSD	1.51	3.41	0.21
1. Design Demands based on California Code of Regulations 22 CCR § 64554 (CDPH, 2009) 2. MGD: million gallons per day 3. ADD: Average Daily Demand is based on data provide in the June 13, 2011, email from Greg Orsini. 4. PHD: Peak Hourly Demand values presented in millions of gallons per hour.			

The ADD is based on data provided by MCSD (MCSD, 2011), as follows:

2010 Calendar Year

Total metered volume from Humboldt Bay Municipal Water District (HBMWD)	552.838 MG
Total number of current services by user:	
Single Family	4,680
Multi-Family	401
Commercial	234
Total volume billed through current services	471.217 MG
Total reservoir capacities	5.25 MG
Total population served	15,400

For the purposes of this preliminary analysis, the conservative metered volume data from the HBMWD was used. As indicated in the California Code of Regulations (CCR), given the amount of limited data, subsections (b).3.(A-D) must be used to develop the ADD, MDD, and PHD (refer to CCR 22 CA ADC § 64554 New and Existing Source Capacity [CDPH, 2009]). The ADD is the total metered volume from HBMWD, 552.8 MG, divided by 365 days/year, equaling 1.51 MGD.

According to the California Department of Public Health and CCR 22 CA ADC § 64554, the system as a whole is required to meet four hours of PHD and MDD at all times. Four hours of PHD is approximately 0.84 MG per four hour period per day, and MDD is approximately 3.41 MG per day. Based on CDPH requirements alone, the system must have a storage capacity of 4.25 MGD.

The current system has 5.25 MG of storage available, leaving a surplus of approximately 1.0 MG. If the 1.0 MG is back calculated through the same techniques used in Table 2, then the surplus storage can be translated into a number of extra ERUs or residences that may be added to the system. If the 1.0 MG is considered the MDD without a fire flow volume, then the ADD for this volume would be 0.33 MGD. This value will supply 1,000 new single family residence services, assuming that there are 2.58 persons per household (DOF, 2008) and 254 gpd per ERU. These calculations are based on theoretical usage of the entire storage volume for the system. To arrive at these numbers, the following assumptions were employed:

- The storage for the entire system is based on the need to supply the distribution system with one day of MDD, four hours of PHD, and one residential fire flow event.
- The calculated number of new households (or single family residences or ERUs) is a theoretical number that uses the entire amount of daily storage. This number does not account for a minimum tank level, minimum pressures to remain in the line at all times (typically 20 pounds per square inch), pumping schedules and efficiencies, or any other intricacies within the system that may limit using the entire daily storage of the system.
- Also, this calculation assumes the system has access to an unlimited source of water that can adequately refill McKinleyville's entire storage system daily.

Preliminary results show that storage in the system is adequate, but a more in-depth review of the historical demand data and an extended-period analysis using a detailed water model may prove otherwise. Also, the requirements listed above from the California Waterworks Standard (CDPH, 2009) are the minimum requirements necessary. Often cities and CSDs will create a list of criteria that are more stringent than the minimum requirements.

MCSD Criteria and Requirements

MCSD requirements and specifications for water distribution systems, including materials, installation, and design criteria, have been developed during the course of determining the system's existing conditions. The MCSD standards are required to meet, at minimum, all California Waterworks Standards and in some cases include more stringent requirements.

- **Operational Storage vs. Total Storage Criterion:** This criterion states that a minimum tank level must be maintained to account for fire flows and/or minimum pressure in the MCSD system. According to MCSD operators, the minimum storage level is approximately 20 feet in each tank. The typical maximum operational storage is around 2.2 MG, while the maximum total storage (actual total tank volume) is 5.25 MG. These numbers may be subject to change based on initial results of the water model, but ultimately the decision will be made by the MCSD Operations group.
- **Minimum Storage Criterion:** This criterion states that the MCSD water distribution system must have enough storage to sustain 5 days of ADD and fire flows. SHN will address fire flows in the future, in the form of how many and what type (residential or commercial) fire flows to apply. Also, we will use daily data provided in the spreadsheets or charts from the last 10 years of the system. This data will provide maximum daily events, diurnal patterns, peak hour events, MCSD's largest recorded fire, and other pertinent data. For now, according to the group's recollection, the ADD is around 1.5 MGD.
- **Extenuating Circumstance Criterion:** This criterion states that due to the vulnerability of the MCSD's sole source of water, the minimum state regulations for water storage are not enough to satisfy MCSD needs in the event of an emergency or natural disaster. The main transmission line from HBMWD crosses the Mad River. If that line were to break, MCSD does not currently have a redundant water supply to refill tanks until the transmission line was repaired. The "Earthquake Scenario" is a situation in which a natural disaster destroys the main transmission line and also causes fire within the MCSD service area. MCSD would need enough storage to provide the average person with water as well as fight multiple fires. Although MCSD is currently investigating potential back up water supply sources, MCSD does not have an alternate source of water other than this transmission line.

- **All other Criteria:** These are typical criteria encountered for most water distribution systems, including, but not limited to:
 - The distribution facilities, wherever possible, will be in grid form for pressure equalization.
 - Water mains will have sufficient valving to prevent the shutdown of transmission mains or the removal from service of more than 500 lineal feet of pipe.
 - Fire hydrants will have a maximum normal spacing of 500 feet in residential areas and 300 feet in commercial areas. Not more than one hydrant is allowed on a 6-inch main between intersecting lines, and not more than two hydrants are allowed on an 8-inch main between intersecting lines.
 - A residual service pressure 20 pounds per square inch gauge (psig) will be available to residents during fire flow demand incidents and a minimum operating pressure 40 psig.
 - Fire flows are based on typical industry standards and typical city standards throughout Humboldt County. The minimum fire flows for residential areas are 1,000 gpm for at least a 2-hour period and commercial areas are 2,000 gpm for at least a 2-hour period. However, there is a historical record of a large fire on September 16, 2002, that lasted for 10 hours and consumed nearly 1.3 million gallons of water.

After considering these standards, criteria, and requirements, MCSD has set a standard for the district that is above and beyond the minimum standard. MCSD requires that the system be capable of storing a minimum of 5 days of ADD at any given time. Therefore the new minimum storage would be approximately 7.6 MG, making the current total storage inadequate. This new minimum requirement would provide adequate water supply to meet the MDD set forth by the State of California, maintain operational storage in the system, maintain minimum pressures in the system, and provide extra storage for emergencies and fire flows.

Potential Future Demand Conditions

With the possibility of future development of high-density housing in the MCSD service area, additional demand will need to be satisfied. The proposed new housing, as per the McKinleyville General Plan, will increase the population served by the MCSD by approximately 1,800 ERUs. Providing the average usage for the service area of 254 gal/ERU increases the ADD by 457,200 gpd.

Applying the MCSD storage criterion of 5 days of ADD increases the required storage by 2.3 MG for this increase in population, in addition to the current storage deficit of 2.3 MG. This brings the total required additional storage to roughly 4.6 MG. By using the criterion of 5 days of ADD for storage, minimum CDPH storage requirements are met, as is the demand for a large fire contingency.

A conceptual cost opinion was completed for new tank(s) with storage capacity of 4.5 MG. At the request of MCSD staff, the cost values shown are for welded steel fabrication, which may or may not be the most appropriate choice for the proposed site. Significant soil excavation is necessary for construction of tanks at this site, and buried concrete fabrication would eliminate the need for additional structures, such as retaining walls. Please note that this is a conceptual design cost opinion only and there may be additional costs for the actual design and construction.

Two options were reviewed to meet MCSD storage needs: One (1), 4.5-MG tank (Table 3a) and two (2), 2.25-MG tanks (Table 3b).

Table 3a Option A – One, 4.5-Million Gallon Tank				
Item	Unit	Quantity	\$/Unit	Item Cost
Mobilization/Demobilization	LS	1	\$40,000	\$40,000
4.5 Million Gal Tank	LS	1	\$2,600,000	\$2,600,000 ¹
Excavate Soil	CY	25,000	\$5	\$125,000
Soil Disposal	CY	20,000	\$10	\$200,000
Fill Import	CY	1,000	\$50	\$50,000
Fill Placement/Compaction	CY	1,000	\$30	\$30,000
Tank Foundation- Concrete	CY	360	\$200	\$72,000
Tank Foundation Rebar	TON	12	\$2,000	\$23,000
Soil Nail Wall	SF	3,000	\$150	\$450,000
18" DI Pipeline	LF	350	\$200	\$70,000
Site Improvements	LS	1	\$75,000	\$75,000 ²
Clearing and Grubbing	LS	1	\$10,000	\$10,000
Engineering	LS	1	\$262,150	\$262,150
Const Management	LS	1	\$299,600	\$299,600
Const Inspection	LS	1	\$37,450	\$37,450
			Subtotal	\$4,344,200
			30% Contingency	\$1,303,260
			Total	\$5,647,460

Notes:

1: Includes painting, coating, cathodic protection, accessories

2: Includes fencing, paving

Table 3b Option B – Two, 2.25-Million Gallon Tanks				
Item	Unit	Quantity	\$/Unit	Item Cost
Mobilization/Demobilization	LS	1	\$40,000	\$40,000
2 x 2.25 Million Gal Tanks	EA	2	\$1,700,000	\$3,400,000 ¹
Excavate Soil	CY	50,000	\$5	\$250,000
Soil Disposal	CY	40,000	\$10	\$400,000
Fill Import	CY	2,000	\$50	\$100,000
Fill Placement/Compaction	CY	2,000	\$30	\$60,000
Tank Foundation- Concrete	CY	550	\$200	\$110,000
Tank Foundation Rebar	TON	18	\$2,000	\$36,000
Soil Nail Wall	SF	7,500	\$150	\$1,125,000
18" DI Pipeline	LF	350	\$200	\$70,000
Site Improvements	LS	1	\$100,000	\$100,000 ²
Clearing and Grubbing	LS	1	\$10,000	\$10,000
Engineering	LS	1	\$399,070	\$399,070
Const Management	LS	1	\$456,080	\$456,080
Const Inspection	LS	1	\$57,010	\$57,010
			Subtotal	\$6,613,160
			30% Contingency	\$1,983,948
			Total	\$8,597,108

Notes:

1: Includes painting, coating, cathodic protection, accessories

2: Includes fencing, paving

Summary

The existing conditions of the MCSD water distribution system were evaluated using data provided by MCSD (MCSD, 2011), minimum standards found in the California Waterworks Standards (CDPH, 2009), and criteria developed by the MCSD Operations Department. According to the data provided by MCSD (shown in Tables 1 and 2), on average 1.51 MG of water is used on a daily basis. The California Waterworks Standards state that the MCSD is required to have the capacity to store, at minimum, the Maximum Daily Demand (MDD) (2.25 times the ADD) and four hours of Peak Hourly Demand (PHD) (1.5 times the average hourly demand of the MDD). Applying these peaking factors, MCSD is required to have minimum storage of 4.25 MGD. Currently, MCSD has 5.25 MGD of storage available, which meets the minimum requirements set by the CDPH's California Waterworks Standards. This value does not account for fire flow storage, maintaining minimum and operating system pressures, or typical operational storage.

When using the minimum requirements, MCSD has adequate storage; when the stated criteria are put into place, the existing storage becomes inadequate. The actual extra storage is 1.0 MGD (5.25 MGD Total Storage – 4.25 MGD CDPH minimum storage). The 1.0 MG of excess would not be adequate for a 1.3 MG fire, like the one that occurred on September 16, 2002, while still supplying the residents of the MCSD.

Also, MCSD requires the system be capable of storing a minimum of 5 days of ADD at any given time. Therefore the new minimum storage would be approximately 7.6 MG, making the current total storage inadequate.

A population growth is used to estimate an increase in population over a given period of time. Using the projected populations is necessary when calculating and designing adequate storage for the future of MCSD. The proposed increase of 1,800 ERUs adds 2.3 MG to the required storage volume for the MCSD service area.

In summary, the current total storage for the district is not adequate when applying the State of California's minimum requirements and historical fire flow volumes. Therefore, the final determination of adequate storage for MCSD will be based on the district's minimum requirement of 5 days of average daily demand, or 9.8 MG. This requires MCSD to increase its current water storage by 4.5 MG.

References

- California Department of Public Health, Water-Related Activities. (January 2009). "Chapter 16–California Waterworks Standards," *California Regulations Related to Drinking Water–Titles 17 and 22 California Code of Regulations*. Sacramento:CDPH.
- Chicago Bridge and Iron. 2011. *Verbal conversation with representative and SHN Engineer Jared O'Barr*. August 5th, 2011.
- McKinleyville Community Services District (MCSD), 2011. *Emails and Conversation with Greg Orsini - Operations Director*. Spreadsheets: "Multi Unit Residential Water Consumption," May-July 2011.
- SCCI. 2011. *Verbal conversation with SCSI Tanks Sales Representative and SHN Engineer Jared O'Barr*. August 2nd, 2011.